

What is claimed is:

- 1 1. A silicoaluminophosphate molecular sieve comprising a surface
2 heat impregnated with a metal selected from the group consisting of Group IIA
3 metals, Group IIIA metals, Group IB metals, Group IIB metals, Group IIIB
4 metals, Group VIB metals, Group VB metals, Group VIB metals, Group VIIIB
5 metals, Group VIIIB metals, and mixtures thereof.
- 1 2. The silicoaluminophosphate molecular sieve of claim 1 wherein the
2 silicoaluminophosphate molecular sieve is selected from the group consisting of
3 SAPO-5, SAPO-8, SAPO-11, SAPO-16, SAPO-17, SAPO-18, SAPO-20, SAPO-
4 31, SAPO-34, SAPO-35, SAPO-36, SAPO-37, SAPO-40, SAPO-41, SAPO-42,
5 SAPO-44, SAPO-47, SAPO-56, the metal containing forms thereof, and mixtures
6 thereof.
- 1 3. The silicoaluminophosphate molecular sieve of claim 2 wherein the
2 silicoaluminophosphate molecular sieve is selected from the group consisting of
3 SAPO-18, SAPO-34, SAPO-35, SAPO-44, SAPO-47, and mixtures thereof.
- 1 4. The silicoaluminophosphate molecular sieve of claim 3 wherein the
2 silicoaluminophosphate molecular sieve is selected from the group consisting of
3 SAPO-34A, SAPO-34B, and mixtures thereof.
- 1 5. The silicoaluminophosphate molecular sieve of claim 1 wherein the
2 silicoaluminophosphate molecular sieve comprises 0.5 to 40 percent by weight of
3 the metal.
- 1 6. The silicoaluminophosphate molecular sieve of claim 5 wherein the
2 silicoaluminophosphate molecular sieve comprises 1 to 20 percent by weight of
3 the metal.
- 1 7. The silicoaluminophosphate molecular sieve of claim 6 wherein the
2 silicoaluminophosphate molecular sieve comprises 1 to 10 percent by weight of
3 the metal.

1 8. The silicoaluminophosphate molecular sieve of claim 1 wherein the
2 metal is selected from the group consisting of aluminum, magnesium, calcium,
3 barium, lanthanum, titanium, chromium, iron, cobalt, nickel, copper, zinc, and
4 mixtures thereof.

1 9. The silicoaluminophosphate molecular sieve of claim 8 wherein the
2 metal is copper, zinc, or a mixture thereof.

1 10. The silicoaluminophosphate molecular sieve of claim 9 wherein the
2 molecular sieve comprises the metal of 1 to 20 percent by weight based on the
3 total weight of the molecular sieve.

1 11. The silicoaluminophosphate molecular sieve of claim 1 wherein the
2 metal is a heat decomposition product of a metal acetate, metal nitrate, metal
3 sulfate, or metal halide.

1 12. The silicoaluminophosphate molecular sieve of claim 1 wherein the
2 surface is heat impregnated with the metal at a temperature from 30°C to 400°C.

1 13. The silicoaluminophosphate molecular sieve of claim 12 wherein
2 the surface is heat impregnated with the metal at a temperature from 120°C to
3 260°C.

1 14. The silicoaluminophosphate molecular sieve of claim 13 wherein
2 the surface is heat impregnated with the metal at a temperature from 160°C to
3 220°C.

1 15. A silicoaluminophosphate molecular sieve catalyst comprising:
2 a surface heat impregnated with a metal selected from the group
3 consisting of Group IIA metals, Group IIIA metals, Group IB metals, Group IIB
4 metals, Group IIIB metals, Group VIB metals, Group VB metals, Group VIB
5 metals, Group VIIB metals, Group VIIIB metals, and mixtures thereof; and
6 a binder.

1 16. The silicoaluminophosphate molecular sieve catalyst of claim 15
2 wherein the silicoaluminophosphate molecular sieve is selected from the group
3 consisting of SAPO-5, SAPO-8, SAPO-11, SAPO-16, SAPO-17, SAPO-18,
4 SAPO-20, SAPO-31, SAPO-34, SAPO-35, SAPO-36, SAPO-37, SAPO-40,
5 SAPO-41, SAPO-42, SAPO-44, SAPO-47, SAPO-56, the metal containing
6 forms thereof, and mixtures thereof.

1 17. The silicoaluminophosphate molecular sieve catalyst of claim 16
2 wherein the silicoaluminophosphate molecular sieve is selected from the group
3 consisting of SAPO-18, SAPO-34, SAPO-35, SAPO-44, SAPO-47, and mixtures
4 thereof.

1 18. The silicoaluminophosphate molecular sieve catalyst of claim 17
2 wherein the silicoaluminophosphate molecular sieve is selected from the group
3 consisting of SAPO-34A, SAPO-34B, and mixtures thereof.

1 19. The silicoaluminophosphate molecular sieve catalyst of claim 15
2 wherein the silicoaluminophosphate molecular sieve comprises 0.5 to 40 percent
3 by weight of the metal.

1 20. The silicoaluminophosphate molecular sieve catalyst of claim 19
2 wherein the silicoaluminophosphate molecular sieve comprises 1 to 20 percent by
3 weight of the metal.

1 21. The silicoaluminophosphate molecular sieve catalyst of claim 20
2 wherein the silicoaluminophosphate molecular sieve comprises 1 to 10 percent by
3 weight of the metal.

1 22. The silicoaluminophosphate molecular sieve catalyst of claim 15
2 wherein the metal is selected from the group consisting of aluminum, magnesium,
3 calcium, barium, lanthanum, titanium, chromium, iron, cobalt, nickel, copper,
4 zinc, and mixtures thereof.

1 23. The silicoaluminophosphate molecular sieve catalyst of claim 22
2 wherein the metal is copper, zinc, or a mixture thereof.

1 24. The silicoaluminophosphate molecular sieve catalyst of claim 23
2 wherein the molecular sieve comprises the metal at 1 to 20 percent by weight
3 based on the total weight of the molecular sieve.

1 25. The silicoaluminophosphate molecular sieve catalyst of claim 15
2 wherein the metal is a heat decomposition product of a metal acetate, metal
3 nitrate, metal sulfate, or metal halide.

1 26. The silicoaluminophosphate molecular sieve catalyst of claim 15
2 wherein the surface is heat impregnated with the metal at a temperature from 30°C
3 to 400°C.

1 27. The silicoaluminophosphate molecular sieve catalyst of claim 26
2 wherein the surface is heat impregnated with the metal at a temperature from
3 120°C to 260°C.

1 28. The silicoaluminophosphate molecular sieve catalyst of claim 27
2 wherein the surface is heat impregnated with the metal at a temperature from
3 160°C to 220°C.

1 29. The silicoaluminophosphate molecular sieve catalyst of claim 15
2 wherein the binder is selected from the group consisting of alumina, aluminum
3 chlorhydrol, clay, and mixtures thereof.

1 30. A method of making a molecular sieve comprising:
2 a) mixing a metal containing solution with a
3 silicoaluminophosphate molecular sieve, wherein the silicoaluminophosphate
4 molecular sieve contains a template;

5 b). heating the mixture to a temperature between 30°C and
6 400°C to obtain a silicoaluminophosphate molecular sieve having a surface heat
7 impregnated with a metal;

8 c) separating the heated silicoaluminophosphate molecular
9 sieve from the heated metal containing solution; and

10 d) calcining the separated silicoaluminophosphate molecular
11 sieve.

1 31. The method of claim 30 wherein the silicoaluminophosphate
2 molecular sieve is selected from the group consisting of SAPO-5, SAPO-8,
3 SAPO-11, SAPO-16, SAPO-17, SAPO-18, SAPO-20, SAPO-31, SAPO-34,
4 SAPO-35, SAPO-36, SAPO-37, SAPO-40, SAPO-41, SAPO-42, SAPO-44,
5 SAPO-47, SAPO-56, the metal containing forms thereof, and mixtures thereof.

1 32. The method catalyst of claim 31 wherein the
2 silicoaluminophosphate molecular sieve is selected from the group consisting of
3 SAPO-18, SAPO-34, SAPO-35, SAPO-44, SAPO-47, and mixtures thereof.

1 33. The method of claim 32 wherein the silicoaluminophosphate
2 molecular sieve is selected from the group consisting of SAPO-34A, SAPO-34B,
3 and mixtures thereof.

1 34. The method of claim 30 wherein the calcined
2 silicoaluminophosphate molecular sieve comprises 0.5 to 40 percent by weight of
3 the metal.

1 35. The method of claim 34 wherein the calcined
2 silicoaluminophosphate molecular sieve comprises 1 to 20 percent by weight of
3 the metal.

1 36. The method of claim 35 wherein the calcined
2 silicoaluminophosphate molecular sieve comprises 1 to 10 percent by weight of
3 the metal.

- 1 37. The method of claim 30 wherein the metal is selected from the
2 group consisting of Group IIA metals, Group IIIA metals, Group IB metals,
3 Group IIB metals, Group IIIB metals, Group VIB metals, Group VB metals,
4 Group VIB metals, Group VIIB metals, Group VIIIB metals, and mixtures
5 thereof.
- 1 38. The method of claim 30 wherein the metal is selected from the
2 group consisting of aluminum, magnesium, calcium, barium, lanthanum, titanium,
3 chromium, iron, cobalt, nickel, copper, zinc, and mixtures thereof.
- 1 39. The method of claim 38 wherein the metal is copper, zinc, or a
2 mixture thereof.
- 1 40. The method of claim 30 wherein the metal is a heat decomposition
2 product of a metal acetate, metal nitrate, metal sulfate, or metal halide.
- 1 41. The method of claim 30 wherein the surface is heat impregnated
2 with the metal at a temperature from 30°C to 400°C.
- 1 42. The method of claim 41 wherein the surface is heat impregnated
2 with the metal at a temperature from 120°C to 260°C.
- 1 43. The method of claim 42 wherein the is surface heat impregnated
2 with the metal at a temperature from 160°C to 220°C.
- 1 44. The method of claim 30 wherein, the mixture is heated at
2 autogeneous pressure.
- 1 45. The method of claim 30 wherein the metal containing solution has
2 a metal concentration between 0.01 M and 1.0 M.
- 1 46. The method of claim 45 wherein the metal containing solution has
2 a metal concentration between 0.05 M and 0.5 M.

1 47. The method of claim 46 wherein the metal containing solution has
2 a metal concentration between 0.08 M and 0.3 M.

1 48. The method of claim 30 wherein the metal containing solution
2 comprises metal salts selected from the group consisting of acetates, nitrates,
3 sulfates, halides, and mixtures thereof.

1 49. A method of making an olefin from an oxygenate feedstock
2 comprising:
3 providing a catalyst comprising a silicoaluminophosphate
4 molecular sieve having a surface heat impregnated with a metal selected from the
5 group consisting of Group IIA metals, Group IIIA metals, Group IB metals,
6 Group IIB metals, Group IIIB metals, Group VIB metals, Group VB metals,
7 Group VIB metals, Group VIIB metals, Group VIIIB metals, mixtures thereof,
8 and a binder; and
9 contacting the oxygenate feedstock with the catalyst.

1 50. The method of claim 49 wherein the silicoaluminophosphate
2 molecular sieve is selected from the group consisting of SAPO-18, SAPO-34,
3 SAPO-35, SAPO-44, SAPO-47, and mixtures thereof.

1 51. The method of claim 49 wherein the metal is copper, zinc, or a
2 mixture thereof.

1 52. The method of claim 51 wherein the silicoaluminophosphate
2 molecular sieve comprises 1 to 20 percent by weight of the metal.

1 53. The method of claim 49 wherein the oxygenate feedstock
2 comprises methanol.